SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 11, 1905.

CONTENTS.

Biology and Mathematics: PROFESSOR GEORGE BRUCE HALSTED..... 161

The Admission of Students to College by Certificate: PRESIDENT GEORGE E. MACLEAN.. 167

Scientific Books:—

Ames's Text-book of General Physics: PROFESSOR W. LE CONTE STEVENS. *Aldrich's Catalogue of North American Diptera:* CHARLES T. BRUES..... 175

Scientific Journals and Articles..... 177

Discussion and Correspondence:—

The Needs of Scientific Men: T. D. A. COCKERELL. *The Editorship of the Engineering and Mining Journal:* R. T. H..... 178

Special Articles:—

A Footnote to the Ancestral History of the Vertebrate Brain: PROFESSOR WILLIAM A. LOCY. *The Importance of Investigations of Seedling Stages:* J. A. HARRIS..... 180

Current Notes on Meteorology:—

Cyclonic and Anticyclonic Temperatures; Meteorology at Colorado College; Neolithic Dew-Ponds; Pilot Charts of North Atlantic and North Pacific Oceans; Suicide and the Weather: PROFESSOR R. DEC. WARD..... 186

Recent Vertebrate Paleontology: H. F. O..... 188

Scientific Notes and News..... 189

University and Educational News..... 191

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

BIOLOGY AND MATHEMATICS.[1]

THAT which is most characteristic of the present epoch in the history of man is undoubtedly the vast and beneficent growth of science.

In things apart from science, other races at times long past may be compared to the most civilized people of to-day.

The lyric poetry of Sappho has never been equaled. The epic flavor of Homer, even after translation, comes down to us unsurpassed through the ages.

Dante, the voice of ten silent centuries, may wait another ten centuries before his medieval miracle of song finds its peer.

The Apollo Belvidere, the Venus of Milo, the Laocoon, are the glory of antique, the despair of modern sculpture. To mention oratory to a schoolboy is to recall Demosthenes and Cicero, even if he has never pictured Cæsar, that greatest of the sons of men, quelling the mutinous soldiery by his first word, or with outstretched arm, in Egypt's palace window, holding enthralled his raging enemies, gaining precious moments, *time*, the only thing he needed to enable him to crush them under his dominant intellect.

There is no need for multiplying examples. The one thing that gives the present generation its predominance is science.

All criticisms of life made before science had taken its present place, or attempting to ignore its prominence, are obsolete, as are of necessity any systems founded on pre-scientific or anti-scientific conceptions.

[1] Address before the Ohio Academy of Science.

Now the latest of the great sciences is biology, and it could be so widely interpreted as to include many of the others, for example, physiology, psychology, sociology; but chiefly it takes for itself the broad general beginnings.

These older sciences were really engaged upon narrow domains, narrow ramifications in the universe of biology; and the general has helped the preexistent special by giving the broader conceptions connoted by comparative physiology, comparative psychology, comparative sociology.

Since Wöhler, the distinction between organic and inorganic matter has become merely schematic; but the line drawn at life has resisted obliteration.

It is true that my friend Professor Herrera has said:

> I conceive the human organism as a machine containing some five or six liters of blood employed in appropriating to itself the nutritious principles of food, absorbing oxygen, and carrying it to the nerve to make it vibrate by discharges of carbon dioxide.
>
> Life is now to be defined as the result of the physicochemical action of protoplasmic currents, the cause of such currents being diffusion, heat and some other secondary factors.

But until some one sees such currents set up in some way differing from the natural transmission of preexistent life, a thing which no one at present even hopes for, the old boundary remains undisturbed.

If any benefit is obtainable from a physico-chemical nomenclature and notation, science will not object to their use.

Suppose, then, we put it in the boldest form, that biology is now engaged in the creation of an available representation of the activities and laws of activity of these wonderful protoplasmic currents.

The definition then would be something like this: Biology is the science created to give understanding and mastery of the protoplasmic activities on this earth; to make easy the explanation and description of such activities and the transmission of this mastery.

The association, the suggestion, is immediate:

Beyond the microtome, the microscope, the statistics of observation, of experiment, of what instrument of world-conquest must the new science avail herself? The answer is patent: of mathematics, that giant pincers of scientific logic which showed Newton the moon as simply a bigger apple trying to fall straight down on his head, flashed out in the mind of Adams the unseen planet Neptune, told Rayleigh that the chemists had always been breathing vast quantities of argon without knowing it, pointed to Mendelieev the places of unknown chemical elements, and through Helmholtz and his pupil Hertz has given us the Lenard rays, the Roentgen rays, radium itself, and wireless telegraphy based on Hertzian waves.

In mathematics, the part which is being recognized as pure deductive logic is ever greater. The residuum takes from biological advance itself new form and new statement.

After the questions, what are facts? what is reality? questions not to be answered either by biology or mathematics, there come, if we decide to retain as rough working hypotheses the expressions, fact, reality, subsequent questions, such as what then is a *geometric* fact, a *geometric* reality?

These latter questions involve a wrestling with primitive origins in physiological psychology, now entangled with metaphysical constructions, all being studied at present with help of the biologically given hypothesis of evolution.

To note the essential interrelation of biology and mathematics it is only needful to recall that evolution postulates a world independent of man, preceding man, and

teaches the production of man from lower biologic forms by wholly natural causes.

If this be so, then skipping the fundamental puzzle as to how a living thing gets any conscious knowledge, any subjective representation of that independent world, it remains of the very essence of the doctrine of evolution that man's knowledge of this independent world, having come by gradual betterment, trial, experiment, adaptation, and through imperfect instruments, for example, the eye, can not be metrically exact.

In the easiest measurements it is said we can not even with the best microscopes go beyond one one millionth of a meter; that is, we are limited to seven significant figures at most. What is the meaning then of the mathematics which, as in the case of the evaluation of π, has gone to seven hundred places of significant figures?

If then we are to hold to evolution, science must be a construction of the animal and human mind; for example, geometry is a system of theorems deduced in pure logical way from certain unprovable assumptions precreated by auto-active animal and human minds.

So also is biology. But here the assumptions are more fluctuating, and many of them are still on trial.

Since every science strives to characterize as to size, number, and, where possible, spatial relations, the phenomena of its domain, each has need of the ideas and methods of mathematics. One of the fundamental ideas of mathematics is the idea of variation, the variable, qualitative and quantitative variability.

When related quantities vary, one may vary arbitrarily. This is called the independent variable. Others may vary in dependence upon the first. Such are called dependent variables or functions of the independent variable. The change of the variables may be continuous or discontinuous. The blind prejudice for the assumption of continuity is so profound as to be unconscious.

But if biologists did but know it, the characteristics, peculiarities and methods of investigation for continuous functions differ essentially from those for discontinuous functions.

Our calculus assumed continuity in all its functions, and also that differentiability was a necessary consequence of this continuity.

Lobachevski, the creator of the non-Euclidean geometry, emphasized the distinction between continuity and differentiability, therein also being half a century in advance of his contemporaries.

The mathematicians of the eighteenth century did not touch the question of the relation between continuity and differentiability, presuming silently that every continuous function is *eo ipso* a function having a derivative.

Ampère tried to prove this position, but his proof lacked cogency. The question about the relation between continuity and differentiability awoke general attention between 1870 and 1880, when Weierstrass gave an example of a function continuous within a certain interval and at the same time having no definite derivative within this interval (non-differentiable).

Meanwhile, Lobachevski, already in the thirties, showed the necessity of distinguishing the 'changing gradually' (in our terminology, continuity) of a function and its 'unbrokenness' (now, differentiability).

With especial precision did he formulate this difference in his Russian memoir of 1835: 'A Method for Ascertaining the Convergence,' etc.

A function changes gradually when its increment diminishes to zero together with the increment of the independent variable. A function is unbroken if the ratio of these two increments, as they diminish, goes over insensibly into a new

function, which consequently will be a differential coefficient. Integrals must always be so divided into intervals that the elements under each integral sign always change gradually and remain unbroken.

In more detail Lobachevski treated this question in his work, 'On the Convergence of Trigonometric Series,' in which are also contained very interesting general considerations on functions.

It seems, he writes, that we can not doubt the truth that everything in the world can be represented by numbers, nor the truth that every change and relation in it can be expressed by analytic functions. At the same time a broad view of the theory admits the existence of a dependence only in the sense that we consider the numbers united with one another as if given together.

Now biology deals largely with aggregates of individuals, and then, like the pure theory of numbers, its variables are discrete, and must change by jumps of at least one individual.

A mathematics proper to such investigations has not been accessible to the biologist, for not only has his calculus been founded solely on continuity, but also his geometry has been developed for him on continuity assumptions from the very beginning.

The very first proposition of Euclid is to describe an equilateral triangle on a given sect (a given finite straight line). It begins: 'Let AB be the given sect. From the center A with radius AB describe the circle BCD. From center B with radius BA, describe the circle ACE. From the point C, at which the circles cut one another, etc.' But the whole demonstration is the assumption of this point C. Why must the circles intersect? Not one word is given in proof of this, which is the whole problem.

You may say the circle is a continuous aggregate of points. If so, then the circle can not represent a biologic aggregate of individuals.

Geometry can be treated without any continuity assumption, without continuous circles, in fact without compasses.

Such a geometry, a geometry for biologists, is my own 'Rational Geometry,' the very first text-book of geometry in the world without any continuity assumption.

How biology has been misled in its mathematics you will realize when you recall that geometry and calculus have been the basis of mechanics, mechanics the basis for astronomy and physics, physics the basis for physical chemistry, while even the theory of probability had no discontinuous mathematics specially its own.

Therefore, biologists had clapped over their eyes spectacles of green continuity, and these spectacles colored biologic theories with the following characteristics as enumerated by the Russian Bugaiev: (1) the continuity of phenomena; (2) the permanence and unchangeableness of their laws; (3) the possibility of characterizing a phenomenon by its elementary manifestations; (4) the possibility of unifying elementary phenomena into one whole; (5) the possibility of sketching precisely and definitely a phenomenon for a past or future moment of time.

These ideas make the very essence, the framework, the skeleton of modern biologic theories. They have forced their way in and imbedded themselves as being necessary to make possible the application of the methods of continuity-mathematics to the investigation of nature. They follow out the fundamental characteristics of continuous analytic functions. Therefore, we may designate our modern biology as a continuity-biology.

Thus, as the Russian Alexeieff has pointed out, after the continuity world-scheme had captured the fundamental natural sciences, geometry, mechanics, astronomy,

physics, chemistry, had intrenched itself in them and dowered them with generality, uniformity, universality, it went over gradually with scientific investigators by habit so to say into flesh and blood, and began to penetrate and dominate in physiology, in psychology, in sociology, in biology.

Darwin's attempt to found the law of the evolutionary origin of species is an outcome of the continuity world-scheme, permeated, saturated with its basal idea, continuity.

Just so strengthens itself more and more the persuasion of the continuous growth and continuous perfection of all the elements of human society in its natural advance.

The evolutionary development of social life permeates always more and more the view of the historian. Many writers are so habituated to this continuity world-scheme, that, without sufficiently critical consideration, they apply it where it is essentially inapplicable and inappropriate.

So we have the doctrine of a fatalist causality, denial of efficient freedom of the will, belittling of the idealistic endeavor of mankind, hence the pessimistic attitude toward the whole of human existence.

Paraphrasing a Russian poet:

Nature thus speaks to man:
"Thou mayst be head of creation,
But who gives thee any crown?
Dost thou believe, poor fool, in blind delusion,
That I am slave to thee, and thou my lord and master?
Of the thick veil lift I a corner tip
And Pygmy, then presumst thou
All through me that thou seest?
Seeing thine own small law and plan, art then deluded
Into the holy of holies to have pushed?
Oh fool! I do but nod and wretchedly thou'llt shudder,
Cower like timid dog on the sod. The earth
I shake and suddenly is dust
Thy pride and might, the greatest of thy cities.
War I send and pestilence its sister,
The blooming fields transform I into deserts,
The sea I drink up and the sun shroud I in darkness,
And thou, brute-like, wilt howl with pain, with anguish.
What you strive for and hope, to me that is indifferent.
Pity know I none, and my law of the number
Knows neither weal nor woe, knows neither praise nor blaming.
To unknown lands I stride in war, in whirlwind.
I know no aim, no end and no beginning.
I beget and I destroy, not prating, never angry,
The elephant and the worm, the wise man and the foolish.
So live as all live. Float out on the flood eternal
One instant brief, and vanish then forever.
Presume not stupid-bold with me to wage a contest,
With me eternal mother of all living and all dead."
So thunders nature with a million voices
In hail, in surge, in storm-wind and the lightning.

So much for the continuity world-scheme in biology.

But the latest advances in mathematics have rendered unnecessary for biology the wearing of this misfit garment.

The new mathematics gives now a standpoint for the explanation and treatment of natural phenomena from which the individuality of the biologic elements need not be suppressed.

It has triumphed for its own domain in cases where the continuity methods were wholly inapplicable, where arithmology, discrete mathematics, was called for and victorious.

Such are the problems which relate to the properties of whole numbers, solved so brilliantly in number-theory.

Such again are the questions relating to the enumeration of the geometric forms with n parameters which satisfy n given conditions. These even in the simplest cases showed themselves insoluble until finally between 1860 and 1870 the French mathematicians created special discrete

methods. Thence sprang a wholly new branch of mathematics, enumerative geometry.

A third, an epoch-making universe of discrete mathematics, is the wonderful invariant theory of the great Sylvester and his brother-in-arms Cayley, two men whose loss left the English-speaking world without a single mathematician of first rank, of the rank of Hilbert and Poincaré.

In chemistry this discrete mathematics has shown itself of such use and power that we may assuredly say chemistry owes its present standpoint almost wholly to two lines of advance, both discrete, the atomic structure theory of Kekulé and Mendelieev's periodic system of the chemical elements.

The brilliant and rapid advances in chemistry have come not from suppressing but from stressing the individuality of the elements. Its mathematics has been essentially discrete.

The arithmologic scheme of chemical research, the atomic structure theory of Kekulé, coincides completely with the scheme of the symbolic invariant theory, though both were worked out independently.

Now to biology and sociology, having to do with single individuals differing from one another, in biology cells, in sociology human personalities, the continuity mathematics with its universalism is so ill adapted by its nature that the discrete way of thinking must here soon take the chief rôle, giving as it does large and free play to the individual peculiarities of the elements to be studied.

The continuity thought-way strives to reduce all phenomena of nature to a general mechanism with fate-determined movement. Just contrary to this then is the view that living nature is a rationally-correlated realm, in which everything is harmonic, shows adaptation, strives toward perfection.

Are not the mechanical form-phenomena of the living organism only its most elementary properties, upon which are built others higher, psychic? Now the psychic properties of a living organism can not be studied by observation and comparison of the accompanying mechanical properties unless they flow from these mechanical properties. If these accompaniments be unessential, the psychic properties can not be concluded from them. Here is even yet the battleground.

Biologists are at present emphasizing the statistical method, but upon this modern mathematics has for them another message. They rely upon the method of least squares and mean value. But Chebyshev has demonstrated that not the great number, but the independence of the metric phenomena plays the chief part in the application of the theory of mean value. This independence is the essential requisite, and it is the very thing whose unwarranted assumption vitiates much biologic research.

An illustration may be drawn from fire insurance. From the records of past conflagrations of single houses, if the burning of each one is independent of that of every other, the theory of mean value can get a number which can be counted upon to recur with slight variation from year to year, and upon it can be based the charges for insurance.

To realize how completely this essential requirement may be lacking, we have only to remember the Chicago fire, or the Baltimore fire.

Biologists have treated their combinations as if they were simple summations of independent elements.

More likely are the combinations composed of interdependent factors whose symbolization must be at the simplest a product.

A tremendous illustration of variation under change of stimuli is given by Japan.

For centuries environment and potential variability were in static balance; variation was zero.

Then came Commodore Perry, humiliations to the inordinate pride of a hermit nation, defeats, contempt, a tremendous response to the changes in stimuli, and to-day dark pagan Japan is easily defeating the largest European Christian white nation: variability unchanged, variation the greatest recorded in human history.

According to Quetelet's celebrated law of variability published some years after Darwin's 'Origin of Species,' it is subject to the law of probability, and according to this law the occurrence of variations, their frequency and their degree of variation can be calculated and predicted in the same way as the chance of death, of murders, of fires.

But such applications did not fit actual evolution, since the law is to deal with different degrees of the same qualities, giving a continuity production of species, while as de Vries has so stressed, the origin may be by abrupt jumps, by sports, by mutations.

De Vries has said that a thorough study of Quetelet's law would no doubt at once have revealed the weak point in Darwin's conception of the process of evolution. It would have shown that the phenomena which are ruled by this law and which are bound to such narrow limits, can not be a basis for the explanation of the origin of species.

It rules the degrees and amounts of qualities, but not the qualities themselves.

Species, however, as de Vries says, are not in the main distinguished from their allies by quantities, nor by degrees; the very qualities differ.

How such differences of qualitative character have been created is the burning question. They have not been explained by continuous accretion of individual variations.

The attitude of the new mathematics strongly favors attempts like the mutation theory, based on the abrupt, explosive changes, wholly discrete, which under the name of 'sports' had long been observed and known in horticulture and animal breeding, and of which De Vries has found a whole fusilade being shot off by 'Lamarck's evening primrose.'

Here he says there is no gradual, no continuous change or modification, nor even a common change of all the individuals. On the contrary, he says, the main group remains wholly unaffected by the production of new species. After eighteen years it is absolutely the same as at the beginning. It is not changed in the slightest degree. Yet it produces in the same locality, and at the same time, from the same group of plants, a number of new species diverging in different ways.

The vastly vaunted natural selection, then, can only destroy new species, never create them.

GEORGE BRUCE HALSTED.
KENYON COLLEGE,
GAMBIER, OHIO.

THE ADMISSION OF STUDENTS TO COLLEGE BY CERTIFICATE.[1]

WHICH is better: the western plan of admitting students to colleges and universities by certificates from duly inspected secondary schools, or the eastern method of admitting only by examinations conducted by representative boards or otherwise?

The question assigned me as a topic is a pressing one at this moment in the history of American education. Within a few years it may be determined which plan,

[1] Paper read before the Department of Higher Education of the N. E. A., Asbury Park, N. J., Friday morning, July 7, 1905.

with all it implies in shaping far-reaching educational ideals and practises, shall be national. The terms 'western' and 'eastern' must not import provincial pride, or sound a note of sectionalism.

As a New Englander somewhat late adopted by the west, may it not be the good fortune of the speaker to lead you all in the discussion to common American ground?

We can adopt the words of Miss Lucy Larcom:

> Two worlds I live in—East and West,
> I can not tell which world is best;
> The friends that people both are dear:
> The same glad sun
> Shines into each; far blends with near,
> And then is now—and there is here—
> And both are one.

In truth there is no single 'western' or 'eastern' plan of admitting students to college, though there are dominating practises warranting the use of the terms. Bluntly stated, all the colleges are so anxious to get students that no system is consistently lived up to. They mix the certificate and examination plans, they distribute examinations in time and space, they annex local preparatory schools or have quasi-certified schools of individual tutors and coaches.

From the point of view of the entering student and of the average American, who believes in the widest opportunity for a higher education in a democracy, the existence of twelve gates open day and night in the college Jerusalem may seem desirable. But to the economist and educator the evils of the competition are glaring and threatening, and opposed to this age of the conquests of cooperation and combination.

A glance at the evolution of our methods of admission of students to college will show what evils are imminent, and which is the better plan of admission.

The so-called 'eastern' method of admitting by the examination of the individual student in its earlier form might have been called colonial or English. Originally, each college examined for itself. There was 'personal contact' between the student and examiner. The examination was more or less oral. The appearance and character of the candidate were weighed. With the increase of students and of entrance standards, the substitution of written examinations, first at the college, then at a distance and with the multiplication of studies, the applicants have become not even names, but mere numbers, to be hit at long range by rapid-firing examination-paper guns.

When the colleges began to fire into one another in concentrating their guns upon certain large preparatory schools, and particularly when the big universities brought up their heavy artillery loaded some with ancient and some with modern subjects and methods, the situation became well-nigh intolerable. The secondary school men cried out, and justly 'continually do cry,' and certain great movements were organized. Among the first was the New England Association of Colleges and Preparatory Schools dating from 1885. According to Dr. William C. Collar, of Roxbury, Mass., the association was formed for the purpose of bringing about uniformity in the requirements for college. He believed at the sixteenth annual meeting, in 1901, its work would receive its consummation by providing for admission examinations by a joint examining board as in the middle states and Maryland.[2] He believed these two boards 'would slay the certificate system and longed to see that done.'[3] It was believed that 'the certificate system was making no headway and that the colleges, generally speaking, would be glad to give it up.' On the contrary, apparently

[2] *School Review*, IX., 619, December, 1901.
[3] Page 625.

aroused by the discussion of this very meeting, the friends of the certificate plan formed the next year the New England College Entrance Certificate Board,[4] now consisting of eleven New England colleges.

Mr. Virgil Prettyman, principal of the Horace Mann High School, is an example of the schoolman's cry for relief. In an article on 'College Entrance Requirements and the High School Program of Studies'[5] he contrasts with to-day a generation ago, when a boy was admitted to college with a training which would to-day place him not higher than the junior year of high school. The colleges require a training two years in advance of former times.[6] The increase is in quantity rather than quality. One must know more things. It is a question if he needs to know any one thing better. "The Harvard examinations are arranged in such a way that a boy must keep fresh in at least six studies up to the close of junior year of the preparatory course. Unless a boy passes in at least three subjects (eight credits) no credit whatever is given. It is necessary for the pupils in the last two years of the preparatory course to carry at least six studies abreast. The total result of the present program of studies is haste in preparation, dissipation of energy and interest, physical strain or a tendency to negligence of duties and illiteracy." Mr. Prettyman suggests two remedies (not including the certificate system, in my opinion the cure for his difficulties): "Reduce the number of studies and raise the passing mark or permit the boy to take examinations in three years instead of two, as at present. The necessity for haste and for a cramming process is the greatest burden of the secondary schoolman. Will the colleges lend a helping hand to the school?"

Another representative secondary school man, Mr. Edward J. Goodwin, of Morris High School of New York City, in an article on 'A Comparison of College Entrance Examinations,'[7] shows the blight for secondary schools of separate examinations by the individual universities, and indicates what a great want brought forth when it established the college entrance examination board. His study is a comparison of the questions of this board with those of Harvard, Yale, Princeton and Pennsylvania. He rejoices "in the attempt to evolve a scientific method of examination that shall test the instruction and training of candidates for admission to college with substantial accuracy, without cramping the schools, or blighting the enthusiasm of the teachers. That the college entrance examination board has made invaluable contributions toward the accomplishment of this end can not be doubted."

The rise and progress of the college entrance examination board represents doubtless the best that can be done for 'the eastern method of admitting only by examinations,' and meets, where it is accepted, the evils of the conflicting examinations of competing colleges complained of by the secondary school men. Organized[8] as recently as November 17, 1900, at Columbia, under the inspiration of Nicholas M. Butler, its first secretary, it has grown from eleven colleges and four representatives of the secondary schools in the Association of Colleges and Preparatory Schools in the Middle States and Maryland, to twenty-five colleges and universities and seven representatives of the secondary schools.

It has fulfilled the hope expressed by the editor of the *Educational Review* in 1901, that it would hold annual uniform exam-

[4] First Annual Report, 1902–1903, Providence, Snow & Farnham, 1904.

[5] *Educ. Rev.*, 28: 304–305, October, 1904.

[6] Cf. Professor John H. Wright, of Harvard, *School Review*, V., 700.

[7] *Educ. Rev.*, 26: 440–456, December, 1903.

[8] *Educ. Rev.*, 22: 264, October, 1901.

inations in June, for the entire territory north and east of the Ohio and Potomac.[9] The candidates examined have risen from 973 in 1901 to about 2,100 in 1905. Examinations have just been held at about 160 points in the United States and its dependencies and five points in Europe. A staff of almost 100 readers at the offices in New York City are to pass on more than 20,000 examination papers.[10]

In the words of President Butler: "The board has accepted the opportunity that President Eliot pointed out during the discussion which led to its formation of 'making an immense contribution to American education.'"[11]

In this day of 'cooperative endeavor' it has been whispered, is it possible that the eminent forerunners of the college examination board, the regents of the University of New York, with their tested examination system and its thousands of candidates might join in the combination? Further, there have been movements to make the tests for graduation from secondary schools identical with the tests for admission to college, upon the basis of the college board's examination papers. Mr. Fiske, the present secretary, says 'it is to be devoutly wished.'[12] He declares that the work of the board is now almost ready to pass from a temporary initial state to a permanent condition.[13]

Impressed by its record and that the time of its crystallization is at hand, one can not suppress the query—will the college entrance examination board become national? Will it fasten an examination system upon us? Of course, to do this it would have to change its local complexion from a little group of twenty-five institutions centering about Columbia. The tendency to a close corporation, since membership is no longer dependent upon meeting an announced standard, but upon election, would have to be reversed.

After the fashion of the Equitable Life, the nature as well as the vastness of the interests would require the mutualization of stock subject to some form of governmental inspection. To cover the national field the present work of the board would have to be so hugely increased that its present work would appear Lilliputian. Taking the figures of the United States census of 1901–2,[14] and the present modes of the board with the desire accomplished that graduation from the school should be dependent upon passing the board's papers, instead of examinations at 160 points they would be at the 8,127 public and private high schools. The present average of 9½ papers for each graduate would require for the 66,262 graduates, the reading of 629,489 papers in place of the present 20,000 and a staff of above 3,000 readers in place of 100, at an expense upon the present estimate of $5 a candidate or $331,310, in place of the present $10,000.

Though the scheme smacks strongly of concentration and the dangers of bureaucracy and lacks a point of national attachment in the bureau of education as at present organized, there is nothing insuperable in it, if the college entrance examination board system is really better than any other.

Before making answer we must review two or three competing plans. First is that of old-fashioned examinations held by individual colleges. In his annual report last week to the Yale Alumni, President Hadley surprised some by saying 'we shall

[9] *Educ. Rev.*, 22: 531, December, 1901.

[10] Article by Thos. S. Fiske, secretary, in *N. Y. Daily Evening Post*, June 20, 1905.

[11] *Educ. Rev.*, 22: 296, October, 1901.

[12] *Educ. Rev.*, 24: 305, October, 1902.

[13] *Ibid.*, 302, October, 1904.

[14] Annual Rep., 1902, Dept. Interior Com., of Ed., Vol. I., xvii.

probably continue to hold separate examinations instead of joining with other colleges.'[15] We may take him as the fairest and ablest protagonist of the old way, while recognizing possibilities of new ways, as is shown by his address on 'The Use and Control of Examinations' before the department of superintendence of the National Educational Association in February, 1901.[16] In brief he says: An examination has two distinct aspects, one looking toward the past, the other toward the future. It is a means of proving a student's past attainment and also of testing his power for that which is to come. A written examination is apt to be a test of the *range* of a student's proficiency rather than of his thoroughness. It loses a major part of its value as a measure of fitness for anything which is to come.

In the passage from the high school to college, the evil is felt most seriously because of the complete separation of control and the remoteness of location, which so often make a system of personal consultation impossible. Here is the most acute controversy. Three methods have been devised to make the range of examination questions wider, to supplement the written examinations by other tests like certified note books, to depend upon certificates given by the teachers of the candidates.

The first method may give too much help to the undeserving student. It offers great opportunities for the coach, for hasty cramming and for the evils of the English civil service and university examinations. The second method of supplementing and correcting the results of examinations by accepting certified note-books, etc., has the merits and defects of a compromise. The frank adoption of a certificate system as a whole would be more logical and better.

[15] *N. Y. Daily Times*, June 28, 1905.

[16] *Educ. Rev.*, 21: 286–300, March, 1901.

The third method, a certificate system, without full discussion of its merits and demerits, has much in its favor. A good preparatory teacher in nine cases out of ten can judge of the fitness of his pupils to enter college better than any college entrance examination board. Each teacher also has a freedom in choice of methods which is of great advantage to him and his pupils.

The first obvious objection is that not on account of dishonesty, but of incompetency, a large number of our secondary school teachers can not be trusted to give certificates. Second, the abandonment of an examination by the college takes away an important stimulus for keeping up the standard of admission requirements. The third objection and the decisive argument for the retention of the old plan is that the colleges which insist on examinations think they get a better class of students by that means than by any other. They get the boys who do not shirk a trial. The fable of the choice of the two doors applies. The first door is labeled 'who chooses me shall get what he deserves,' the second, 'who chooses me must hazard all he has.' The certificate system attracts those who would go to the former door, the examination system those willing to venture the latter.

If each of these alternatives thus proves unsatisfactory, is there not some possible combination which may be suggested? Let us divide our requirements into three groups of subjects:

First, the prerequisites for power to go on with collegiate study, viz., mathematics and the required languages, to prove power of precise thought and of precise expression, where the examinations would be maintained in the hands of the college which is to have the student in charge.

The second group of subjects, viz., the

prescribed readings in English literature, in Latin and modern languages, is considered auxiliary to the attainment of power signified by the first group. President Hadley says: "I should be in favor at once of putting all examinations on the extent of knowledge in these auxiliary subjects into the hands of a common examination board. Whether it would be wise to go a step further and introduce the certificate system in subjects of this group, is a matter which I should hardly like to prejudge at present."

In the third group of studies, history and descriptive sciences, which President Hadley assumes are not a necessary basis for subsequent work, but part of a general scheme of secondary education, recognized by the colleges as a concession to satisfy teachers able to teach them and not to degrade these subjects, the certificate system would be allowed from the very outset.

In wrestling with the objections to his combination and complex, if not compromise, system, he finds relief in extending 'to teachers of proved ability the opportunity to recommend at the risk of their own reputation for provisional admission to our freshman classes pupils to whom the new system seemed to have done injustice.' Thus President Hadley is not far from the kingdom of the outright accrediting system for which we hope he may become a leader, not only amongst his brethren of the eleven colleges in the New England College Entrance Certificate Board, but throughout the nation. The whole thing might be done if Commissioner Draper and President Butler became his coadjutors.

There is time for but a moment's glance at the evolution of 'the western plan of admitting students to colleges and universities by certificates from duly inspected secondary schools.'

It might be called the continental or German plan, whence it in part came to reinforce preeminently and first in Michigan, a state system of public schools crowned by a state university. It, in some form, logically accompanied a state public school system with a teaching state university, and has been cheerfully adopted, and to their edification, by the private colleges and universities, so that it covers the entire territory from the Ohio to the Pacific and overflows into southern and eastern states.

In its rudimentary form, which the New England College Entrance Certificate Board has adopted, an applying school is placed on an approved list when it can prepare for a college course, and continue to prove its ability to give preparation for college by the record of its students already admitted to college. The admission of the candidate without a collegiate examination in the subjects for which he is certified as prepared by the approved school is probationary.

Naturally, with the increase of schools and students and with a zeal to maintain standards, there followed the visitation of the approved schools by members of the faculty related to preparatory subjects. Thus informally inspection of schools began, until now there are twelve state or state university inspectors in as many great western states, supplemented by visitors from the faculties including great private institutions.

In the North Central Association of Secondary Schools and Colleges, there has been for six years a commission on secondary schools and college entrance requirements, at the heart of which is a board of high school inspectors. Uniform standards and entrance blanks have been prepared. For some time by comity schools accredited by one state university have been accredited by another. But now a list of first-class schools meeting the standards of the commission is becoming an accredited list throughout the entire northwest. In an-

other way has been attained what President Butler said the college entrance examination board stood for: "Uniformity of definition, topic by topic, with a uniform test, uniformly administered. Each college will continue to fix its own standards of admission and to admit its own students."[17]

The difference is that the examination or uniform test is of the institution and not of the individual, ridding us of the evils of personal and paper examinations, massed so that all is staked at once for the pupil. President Hadley's allusion to the fable of the two doors is too literally true. Entrance examinations become a gamble and the student seeking to gamble is commended.

A long line of witnesses might be cited from inspectors, college and secondary schoolmen working under the plan of certificates from duly inspected schools, all in favor of the plan.

A few citations pertinent to our discussion will help to answer the question before us.

Leon J. Richardson,[18] of the University of California, shows how the accrediting system has evolved rapidly since 1883 in that state, in harmony with republican institutions. The schools voluntarily established their relations with the university and may sever it at will.

Wm. J. S. Bryan, principal of the normal and high school of St. Louis, says the practise of admitting to the university on certificate only the pupils who have graduated from the approved schools has been a powerful lever in raising the standard of the work done.[19]

Edwin G. Dexter,[20] professor of education, University of Illinois, says: "The east has been attempting the system of admission to college through the certificate system —a modified accrediting system—but they have left out of it the high school visitor, and therein lies the trouble. No inspection on the part of a college professor can ever take the place of the visitation of the inspector, the expert of the secondary school system, the trained friend, adviser and helper and visible connecting link with the university." An advantage of the accrediting system is the increased proportion of high school students who go to college. It is suggestive that in the graduating class of the public high schools in the North Atlantic States, the part of our country little given to the accrediting plan, twenty-six per cent. were for the year 1901 in the college preparatory course. In the same class in the North Central States, where accrediting prevails, the percentage was thirty-four. The accrediting system gives the college students with a better average preparation. The University of Pennsylvania receives about an equal number each year upon each of the two plans—individual examination and certificate. In the fall of 1901, 112 entered by the first method, and 101 by the second. At the end of the semester 49 per cent. of those entering by examination were conditioned as against only 29 per cent. of the certificated students. A suggestive but not a conclusive comparison is of the percentage of failure in first year subjects in one of the Atlantic coast universities, admitting only by examination, and those of five of the larger middle west state universities, where eighty per cent. enter without examination. East, failed algebra, 26 per cent.; trigonometry, 34 per cent. West, failed algebra, 15 per cent.; trigonometry, 11 per cent.

Principal Ramsey, of Fall River, some

[17] *Educ. Rev.*, 22: 291, October, 1901.

[18] *School Review*, 10: 615–619, October, 1902.

[19] Proc. 5th Annual Meeting N. C. A. S. S. and C., 11, 1900.

[20] Nat. Conference Secondary Ed., N. W. University, p. 94, October, 1903.

years ago in a study to determine the relative merits of the two methods of college entrance, received answers from college officers in favor of certificated students: In mental ability, five to one; in the general performance of college duties, three to one.

Professor Whitney, of Michigan, investigating the freshman grades of more than 1,000 students, about equally divided between those entering upon credit and those taking entrance examination, found that the average standing of the former was more than one and one half per cent. higher than for the latter.

Impartial testimony might be gleaned from European educators. Professor T. Gregory Foster in the report of the last Alfred Mosely Commission[21] rejoices that it is a fundamental principle in American universities, that the man who is fit to teach is also to be trusted to examine his own students. He remarks: 'As long as examinations control the teaching, whether in universities or schools in this country [Great Britain], so long will the teaching continue to be academic in the worst sense of the word, cribbed, cabined and confined.' He notes the degree to which examinations by external bodies or examiners is regarded as baneful in the United States both to the pupil and for the educational organization, and commends the attempt of the college entrance examination board to guard against some of the evils by having secondary schoolmen on the board. But to Professor Foster the accrediting system of the middle west is 'a more significant plan' and one rapidly spreading into the east. He says: "In the states where it has been adopted, the whole educational system has been unified and strengthened. The barriers between various grades of teachers are being removed. The teaching of all classes of teachers is thereby made more direct, more stimulating and attractive to students. The accrediting system as *versus* the older leaves the teacher and the taught free and thereby stimulates to better training." Professor Foster quotes President Harper as opposed to the accrediting system when he left Yale, but now as a firm believer in it as a result of his experience. The professor concludes: 'It is perhaps one of the most noteworthy contributions of America to educational progress.'

Mr. M. E. Sadler,[22] director of special inquiries and reports, Educational Department of England and Wales, speaks decisively as to certain principles applicable to our discussion:

"State certificates bestowed as results of written examinations at a prescribed moment at the close of their school life, are injurious in their influence as well on the work of the schools as on the physical, mental and ethical development of the pupils and also on the national ideals of education, and on the parents' conception of what education can do and ought to do. The more valuable influences of a secondary school lie in its tone, its ἤθος, in its tradition, in the outlook which it encourages its pupils to take on life and duty, in the relation between teachers and scholars, in the relation among the scholars themselves. None of these things can be tested by written examinations, conducted by examiners, however able or impartial, who have never seen the school. It is judged on *paper*. It is possible for a school to simulate great intellectual efficiency by reason of an intensive process of 'cram' which reflects immense credit on the skill and industry of the teachers, but guarantees little of permanent educational value to the pupils prepared. Yet a system of merely written

[21] Pp. 115–118.

[22] *Educ. Rev.*, 21: 497–515, May, 1901; cf. pp. 507–12.

examinations conducted by examiners at a distance fails and must necessarily fail to discriminate between two effects superficially and temporarily similar, but really and permanently different.''

He adds: 'The natural antithesis to written examinations is a system of inspection.' He weighs the difficulties of inspection in a national provision for secondary education, and would find a formula for some form of consultative committee with the state—'neither to have too much state nor too little state.' ''*Laissez-faire* is impossible in this period of rapid transition.''

This last is true in America. What we do we must do quickly. A national system, meaning thereby governmental coordination and possible inspection in harmony with the voluntary cooperation of private institutions, like the accrediting systems now prevailing in many western states, concatenating secondary schools, colleges and universities, will give modern interstate educational privileges, long needed to keep up with interstate commerce and life and heightening national ideals and power.

The line of evolution is clear. The oral examination of the individual pupil by the separate college, the written examination in the same fashion, the combination of colleges for written examinations, the slight recognition of the preparatory teacher in the combination, the great recognition of the preparatory teacher and his examinations by the certificate plan, and the highest point of evolution, the examination by the combined colleges of the secondary school as a whole, and the accrediting of it organically, trusting it all in all or not at all.

The disappointed hearer who looked for a formal disputation in this paper may be still demanding a categorical answer to the question of our topic 'Which is better, etc.?'

Let him draw his own conclusions from the testimony marshalled from the best representatives of the different systems.

As an evolutionist I see every system has a part to perform, and perceive certain principles at work which promise us not only a better system, but a national and best.

GEORGE E. MACLEAN.
UNIVERSITY OF IOWA.

SCIENTIFIC BOOKS.

Text-book of General Physics for High Schools and Colleges. By JOSEPH S. AMES, Ph.D., professor of physics and director of the physical laboratory in the Johns Hopkins University. New York, American Book Company. 1904. Pp. 768.

About eight years ago Professor Ames published his 'Theory of Physics' and established his reputation as a skillful writer of text-books. The present volume was initially undertaken as a revision of the former one, but the author soon found that it was more convenient to prepare a new book independently, with occasional inclusion of matter that had been previously put into such good form as to require but little modification. He believes now, as then, that to present the subject of physics to a class of students three things are necessary: a good text-book; experimental demonstrations and lectures, accompanied by recitations; and a series of laboratory exercises. This book is intended to state 'the theory of the subject in a clear and logical manner so that recitations can be held on it.'

The class-room presentation of any subject that requires frequent experimental illustration necessitates the abandonment of the text-book by the teacher while engaged in the work of exposition. The text-book becomes the basis for parallel study on the part of the auditor, and recitation days are most conveniently differentiated from exposition days. Presumably the present volume is the writing out of at least the greater part of the lectures given at Johns Hopkins University to the students of general physics, who are assumed not to possess at the outset any knowledge of advanced mathematics. It was probably for

this reason that on the title page the book is said to be 'for high schools and colleges.' The clause 'for high schools' is probably superfluous. If there are any high schools in which a book of this grade can be successfully employed they are quite exceptional.

Assuming that the book is exclusively for collegiate students, or others of equivalent maturity, it is very interesting and suggestive, well up to date, and abundantly worthy of cordial commendation. The first 212 pages are taken up with the mechanics of solids and fluids, each chapter being closed with a well-selected list of books of reference. About 100 pages are then devoted to the phenomena and laws of heat, including a brief chapter on thermodynamics. Vibrations and waves receive quite full treatment, 80 pages being devoted to this subject before that of sound is mentioned. The analysis of sound, musical instruments and musical compositions make up three short chapters, about 27 pages in all. To the subject of light 175 pages are given; and to magnetism and electricity, 167 pages. This may seem like a significant reaction against the popular demand for utilitarianism in physics, but it is not altogether surprising that emphasis should be laid upon the phenomena of heat and light in a laboratory where Rowland's influence in behalf of pure science was so long dominant. The theory of electricity is brought out with much clearness and in excellent style, while less than five pages are devoted to dynamos and the engineering applications of electricity to industry.

A distinct defect in this otherwise excellent book is the complete absence of illustrative problems. The author may, perhaps, prefer to avoid these as class-room tests, or he may use them spontaneously and prefer not printing problems, the solutions of which can be transmitted down from class to class. The majority of teachers are probably agreed that the use of problems is indispensable in the conveying of accurate ideas when the subject is such as necessarily to imply the application of mathematics, whether elementary or advanced.

Possibly a separate small volume of problems, as a supplement to the text-book, may be forthcoming in the near future. If so it will be welcomed by those who use this book either for reference or in the hands of their students. But, even as it stands, it is worthy of the welcome which it can not fail to receive.

W. Le Conte Stevens.

A Catalogue of North American Diptera. By J. M. Aldrich. Smithsonian Miscellaneous Collections, Vol. XLVI., No. 1444. 1905. Pp. 1–680.

The long-expected catalogue of North American diptera by Professor Aldrich has at last appeared. It is the first work of its scope to be published since Baron Osten Sacken's catalogue which was issued by the Smithsonian in 1878. During the intervening quarter of a century the aspect of entomology in North America has greatly changed, more especially in the diptera, rendering the new catalogue most welcome.

The following remarks from Professor Aldrich's introduction show the relation which exists between the two works:

> The great amount of work which has been done on North American Diptera within the quarter of a century has largely changed the face of the subject. Hence the reader will probably observe, especially at first, more of contrast than resemblance. The number of species has doubled; the number of references to previously known species has almost doubled; several families have been monographed or revised, with more or less change of nomenclature; along with this has gone the publication of a multitude of smaller papers, touching every family but one, and the larger part of the genera. Under these conditions it is inevitable that great changes should appear in the new catalogue.

The catalogue is rather unique among the present lists of American insects in several respects, all of them commendable. The faunal limits are not restricted to the countries north of the Mexican boundary, but are extended to include as far as Panama and the West Indies on the south. This gives a much more lasting value to the enumeration of species than is possible when the banks of the

Rio Grande and the gulf coast are regarded as the edge of a zoological chasm, which dare not be crossed except by the numerous Mexican and West Indian species which are discovered every year in Texas and Florida.

The references to strictly anatomical and biological papers are also most useful, representing a phase of the subject which is usually entirely crowded out in an essentially taxonomic catalogue. If future cataloguers of other groups would profit by this example they could greatly enhance the value of their work without an expenditure of much extra space and labor.

The special references under many of the families and separate genera to special papers relating to such groups will prove a great assistance to the inexperienced worker as well as a convenience to others more versed in the scattered literature of the subject.

The bibliography fills some 68 pages, including all papers of any importance published before January 1, 1904, while an appendix covers the literature of 1904.

As must be the case with any catalogue covering so large a group, a great number of generic and specific names have been reduced to synonymy since the last authoritative list. These have been dealt with in an admirable spirit of conservatism which contrasts sharply with the extravagant overturning of names often indulged in by insect cataloguers. To quote the writer's own words: 'I have been influenced by the feeling that my catalogue must represent the actual condition of classification, not merely my own views.'

It is to be hoped that the catalogue will stimulate the increasing interest in this group. It will certainly be a great aid towards accurate dipterological work in this country.

CHARLES T. BRUES.

PUBLIC MUSEUM, MILWAUKEE, WIS.

SCIENTIFIC JOURNALS AND ARTICLES.

THE June number (volume 11, number 9) of the *Bulletin of the American Mathematical Society* contains: Report of the April meeting of the Society, by F. N. Cole; Report of the April meeting of the Chicago Section, by J. W. Young; 'A general theorem on algebraic numbers,' by L. E. Dickson; 'On the deformation of surfaces of translation,' by L. P. Eisenhart; 'The groups of order 2^m which contain an invariant cyclic subgroup of order 2^{m-2},' by G. A. Miller; 'Galileo and the modern concept of infinity,' by Edward Kasner; 'Notes' and 'New Publications.'

The July number contains: 'A survey of the development of geometric methods,' by M. Gaston Darboux, translated by H. D. Thompson; 'Note on Fermat's numbers,' by J. C. Morehead; 'Simply transitive primitive groups which are simple groups,' by H. L. Rietz; 'Remarks concerning the variation of the length of a curve,' by T. J. Bromwich; Review of Joly's Manual of Quaternions, by J. B. Shaw; Shorter notices of Zeuthen's Geschichte der Mathematik in XVI. und XVII. Jahrhundert, by D. E. Smith, and of Tannery's Introduction à la théorie des fonctions d'une variable, by L. E. Dickson; 'Notes' and 'New Publications'; 'Fourteenth annual list of papers read before the society and subsequently published'; Index of volume 11.

THE July number (volume 6, number 3) of the *Transactions of the American Mathematical Society* contains the following articles:

H. POINCARÉ: 'Sur les lignes géodésiques des surfaces convexes.'

T. J. I'A. BROMWICH: 'The classification of quadrics.'

J. E. WRIGHT: 'On differential invariants.'

L. I. NEIKIRK: 'Groups of order p^m, which contain cyclic subgroups of order p^{m-3}.'

G. A. MILLER: 'On the invariant subgroups of prime index.'

E. W. BROWN: 'On a general method for treating motions and its application to indirect perturbations.'

L. E. DICKSON: 'On hypercomplex number systems.'

J. H. MACLAGAN-WEDDERBURN: 'A theorem on finite algebras.'

J. ROYCE: 'The relation of the principles of logic to the foundations of geometry.'

J. PIERPONT: 'On multiple integrals.'

The American Naturalist for July contains an article on the 'Restoration of the Titano-

there Megacerops,' by R. S. Lull, accompanied by an illustration which differs from others previously made in showing the animal with a short, double nasal horn. This, it is argued, was, like that of the rhinoceros, composed of agglutinated hairs. We have another of the 'Synopses of North American Invertebrates,' this, No. XXI., by W. R. Coe, being devoted to the Nemerteans, part I. W. B. Davis gives the sixth paper on 'Studies of the Plant Cell,' and the balance of the number is devoted to reviews and correspondence.

The American Museum Journal for July is termed the Reptile Number, the major part of its contents consisting of a synopsis of 'The Reptiles of the Vicinity of New York City,' by Raymond L. Ditmars, accompanied by a key and numerous excellent illustrations. The article is issued separately as Guide Leaflet No. 19.

The Zoological Society Bulletin for July is as good as its predecessors. C. William Beebe describes 'The New Bird House' at length, giving a number of fine illustrations of the building and its contents. There is an excellent article on 'Labeling Live Animals' with samples of the labels used at the New York Zoological Park, one on 'Tree Planting at the Zoological Park' and another on 'Our Series of Batrachians.' The illustrations are particularly good.

The Museums Journal of Great Britain for July completes the fourth volume of this valuable publication and includes the index. Its leading articles are 'The New Local Museum in Bad Bielohrad, near Jitschin, Bohemia,' by Anton Fritsch, and 'A System for the Registration of the Contents of Museums,' by L. Wray, of the Perak Museum. The interest and value of the *Journal*, however, lie largely in its numerous brief notes relating to many museums.

DISCUSSION AND CORRESPONDENCE.

THE NEEDS OF SCIENTIFIC MEN.

Much has been said recently about the desirability of offering 'brilliant prizes' to men who 'succeed' in science. In Science of July 7, p. 27, are some fresh remarks on this subject, from the address of President Roosevelt to the alumni of Harvard. The time has come when the worm, with the kind permission of the editor, desires to turn.

I write as an ordinary working naturalist, and on behalf of my kind. We neither expect scintillating 'success,' nor do we look forward to any prizes in the way of highly-paid positions. Our needs are mainly two: (1) adequate time for work and (2) a living wage. These are exactly the things we can not have, in the present state of this country. It is only necessary to make a few inquiries among scientific workers, to find out that very few, even among the most distinguished, can pursue their studies unhindered. A very short time ago I had a conversation with one of the most able naturalists America has ever produced, holding an apparently excellent position, and he explained to me how he was obliged to spend a large part of his time in routine work, because of the lack of adequate assistance. A day or two later I talked to a man who has a most intimate knowledge of a certain group of animals, and has discovered many new facts; but few of his discoveries will ever be put in print, because of the incessant pressure of other duties. These men are not part of the 'great unemployed'; they hold positions most people would envy; and, moreover, they are excellent samples of all the rest.

The difficulty is intimately connected with the other one, that of the living wage. There is no living wage for *research;* research in pure science is at present a parasitic industry, to borrow a term from the economists. Both of the men I have just referred to get their salaries for doing economic work, and whatever they do in pure science is supported and made possible by the other. A still larger body of researchers lives upon the proceeds of teaching, while those who *actually get a living by research* are very, very few. The experiment stations, even, do not disobey the general rule, for the demand for immediate results of economic value is such that the workers are almost obliged, in the majority of cases, to desist from work of a broad and fundamental

character; while most of them, of course, have to do a large amount of teaching.

It would be difficult or impossible to overestimate the value of the teaching and economic work referred to. They are indispensable and in every way worthy of the support they receive. But research in pure science—meaning by this term research directed toward ascertaining the methods of nature without immediate economic or educational ends—is even more necessary, for it is the rock on which the other two must necessarily build. It also must be supported—and by whom? Surely by the recipient of the benefits it confers, that is, the human race.

I can not agree with President Roosevelt that the highest work will never be affected by the question of compensation. It will be and is continually affected by the fact that it can not get even the wherewithal to keep the machine at work. On the other hand, it is likely to be totally destroyed, if affected at all, by the offer of 'brilliant positions.' For what are these positions, judging from those now existing? Mainly and often wholly executive; useful and honorable, indeed, but not, in their essence, *scientific* positions at all! Who proposes to pay a man ten thousand a year, and then *leave him alone to go on with his work?* Really, the situation suggests a slang expression, not fitted for the pages of SCIENCE.

I once heard of an Englishman who said he would work hard in science until he got his F.R.S., and would then stop. We do not want men with that spirit, who begin and continue with the hope and expectation of a prize, financial or social. The scientific man has his real prizes, which he values highly and of which he can not be robbed; these are to see his ideas and discoveries woven into the fabric of human knowledge, and become integral and essential parts of the great temple of which he is one of the myriad builders. This alone is to him worth while; and it is a positive injury to divert him with baubles. His prayer is, to be permitted to work as long as life lasts, and that it may be said of him, as I heard it said of that fine old entomologist, J. O. Westwood, in his last years, 'he never gets tired.'

T. D. A. COCKERELL.

THE EDITORSHIP OF THE ENGINEERING AND MINING JOURNAL.

TO THE EDITOR OF SCIENCE: On July 1, 1905, Mr. T. A. Rickard relinquished the managing editorship of the *Engineering and Mining Journal,* a position which he held with merit for two and a half years. Although Mr. Rickard has been succeeded by others who will maintain the high standing of the *Journal* as a technical magazine, his voluntary retirement, in my opinion as an American geologist, is a distinct loss to science in this country, inasmuch as, in addition to his intimate knowledge of the business side of mining, he appreciated the important relation of this subject to geology. Through this appreciation, during his editorial encumbency, he secured and stimulated many excellent original contributions upon the geology of interesting localities, which would not otherwise have been published.

Of all the economic applications of geology, the questions pertaining to the origin, occurrence and availability of ore deposits are by far the most important, and, perhaps, the sympathy and encouragement of mining men have been the greatest impetus in this country toward securing the means of purely scientific research.

The numbers of the *Journal* edited by Mr. Rickard constitute a most valuable addition to the annals of American geology, and it is hoped that the talents of business integrity, high idealism and charming literary style, so rarely found in combination with scientific knowledge and so well developed in him, will not long continue idle.

That Mr. Rickard has recently declined a professorship of mining in the Royal School of Mines, a position which carries with it title and honor, and has chosen to remain in America, will be gratifying to all of his confrères in the geological profession.

R. T. H.

SPECIAL ARTICLES.

A FOOTNOTE TO THE ANCESTRAL HISTORY OF THE VERTEBRATE BRAIN.

THE existence of a pair of newly recognized ganglionated nerves, attached to the fore-brain of that ancient group of fishes—the Selachians—is, perhaps, of sufficient general interest to justify a brief mention in SCIENCE.

In recent numbers of the *Anatomischer Anzeiger* (Vol. XXVI., Nos. 2/3 and 4/5) the writer has described and illustrated the morphology of such nerves in twenty genera, and twenty-seven species, of selachians, and their embryonic history in one. Similar nerves have also been pointed out by Allis, Pinkus and Sewertzoff in two of the Dipnoi (*Protopterus* and *Ceratodus*), and one ganoid (*Amia*). So far as observations go these nerves are absent in all other vertebrates. The facts now made known, although in one sense merely anatomical details, may, nevertheless, be looked on as constituting a footnote to the great chapter in morphological science dealing with the structure and development of the vertebrate brain.

The fore-brain is extremely modified in structure, and so little understood that it is desirable to gain any new facts bearing on its organization. So far, comparative anatomy and embryology combined have supplied only fragmentary views as to its nature, the number of segments that may enter into it (or, indeed, whether it is segmented at all), and as to its line of development. Although the solution of these matters is likely to take many more generations, yet, in the meantime, details of structure hitherto unknown may help, be it ever so little, in the anatomical analysis of that region of the brain.

The new nerves referred to above exist in adult stages of selachians. They are, on the one hand, connected with the fore-brain and, on the other, with the olfactory epithelium. They arise earlier in embryonic history than the olfactory nerves, appearing on the anterior summit of the fore-brain near the neuropore. Peripherally they intermingle with the olfactory fibers, but, at all stages of their existence, they are entirely independent of those fibers, and they never come into relation with glomeruli as the olfactory fibers always do.

As to their surface connections with the brain wall, they exhibit two types: those having a dorsal or semidorsal attachment to the brain-wall, and those having a ventral attacument. It is, however, to be borne in mind that the superficial attachment of a nerve is of small significance in determining its position, as in the case of the fourth nerve, which

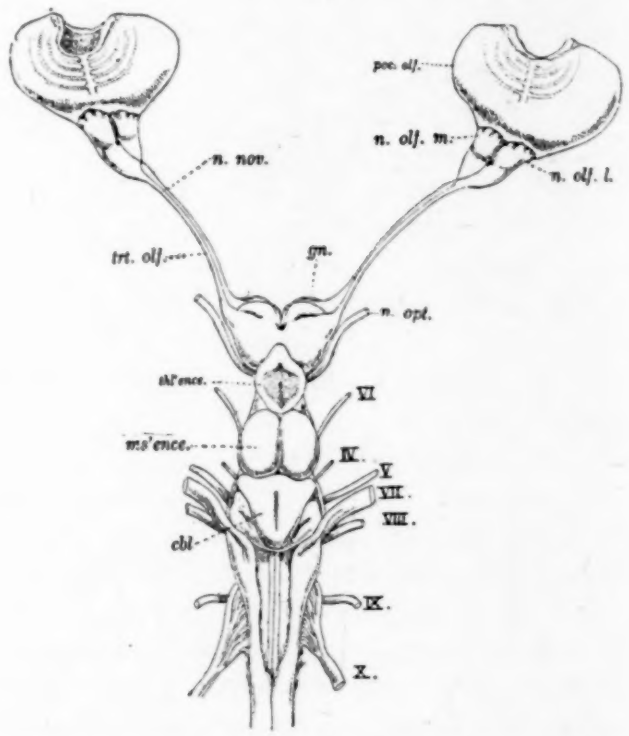

FIG. 1. Brain of *Squatina angelus*, from above, natural size.

emerges from the dorsal surface of the mid-brain, while its neuroblasts lie in the ventral zone.

As an illustration of the first type, reference may be made to Figs. 1 and 2 showing, respectively, the brain of the angel-fish (*Squatina angelus*) and that of the spiny dog-fish (*Squalus acanthias*), one of our commonest selachians.

In Fig. 1 the new nerve (*n. nov.*) is seen attached by two roots to the dorsal surface of the prosencephalon, and, bearing just in front of the brain, a filiform ganglion (*gn.*). From this point it runs like a delicate thread along the olfactory tract, and dips into a fissure separating the two great divisions of

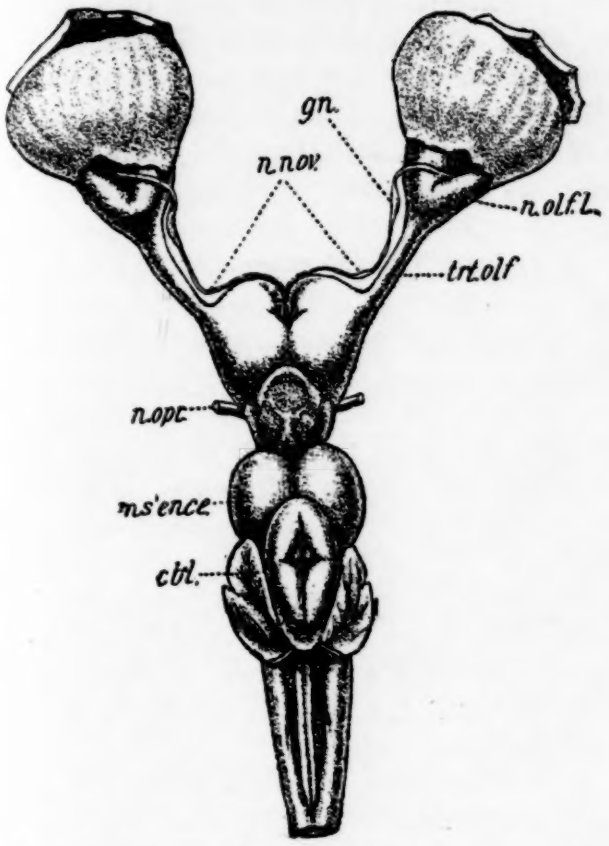

FIG. 2. Brain of adult *Squalus acanthias*, from above, natural size.

the olfactory nerve. Thereafter it branches and passes to portions of the nasal epithelium.

In *Squalus acanthias*, Fig. 2, the central ends of the nerve are located within the median furrow of the fore-brain, and its ganglion (*gn.*) is near the base of the olfactory bulb.

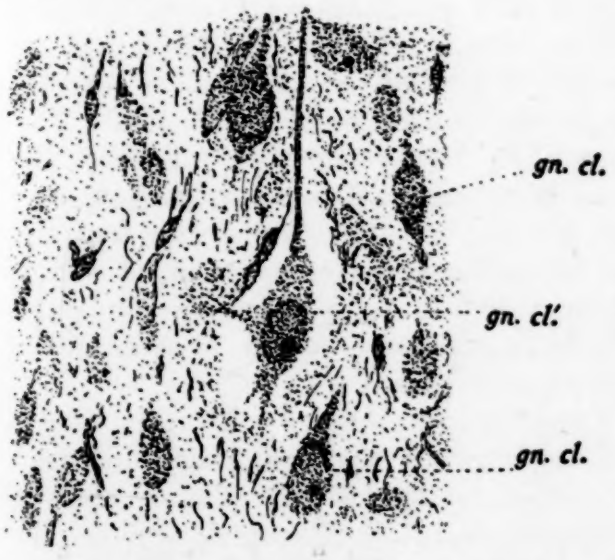

FIG. 3. Section of the ganglion of the new nerve of *Squalus acanthias*, × oc. 2, obj. 2/3 in.

The microscopic structure of the ganglion, shown in Fig. 3, resembles that of a spinal ganglion. It is surrounded by a covering of connective tissue from which supporting strands pass into the interior of the ganglion. The ganglion-cells are arranged in clusters and layers between the nerve fibers and connective tissue elements. The nerve-cells are for the most part bipolar (*gn. cl.*), but a limited number of other ganglion cells (*gn. cl.'*), with angular outlines and several processes leading from them, may also be seen, which suggest the presence of multipolar cells.

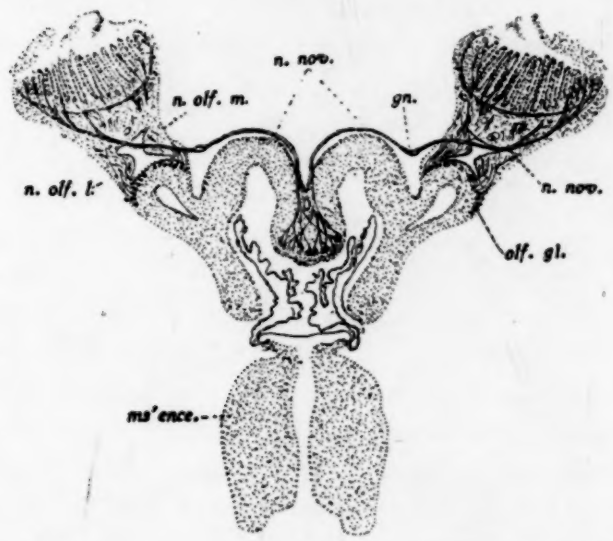

FIG. 4. Partly diagrammatic figure of a horizontal section of the brain of *Squalus acanthias* six inches long. Showing portion of the central and peripheral endings of the new nerve.

The central terminations and peripheral distribution of the new nerve are shown in Fig. 4. This is partly diagrammatic, being based on a section in the horizontal plane of the brain of a *Squalus acanthias* about six inches long. Centrally, the nerve fibers enter the brain substance, and after much branching are distributed mainly within an eminence upon a median infolding of the pallium. This eminence is supposed to correspond to that designated '*eminentia septalis*' by von Kupffer in the amphibian brain.

The study of serial sections shows that the fibers of the chief branches of the nerve are distributed, peripherally, to the olfactory membrane, in the antero-lateral portion of the olfactory cup. There are also some smaller

branches passing to the median portion of the cup. While the terminal twigs mingle intimately with the olfactory fibers, they retain

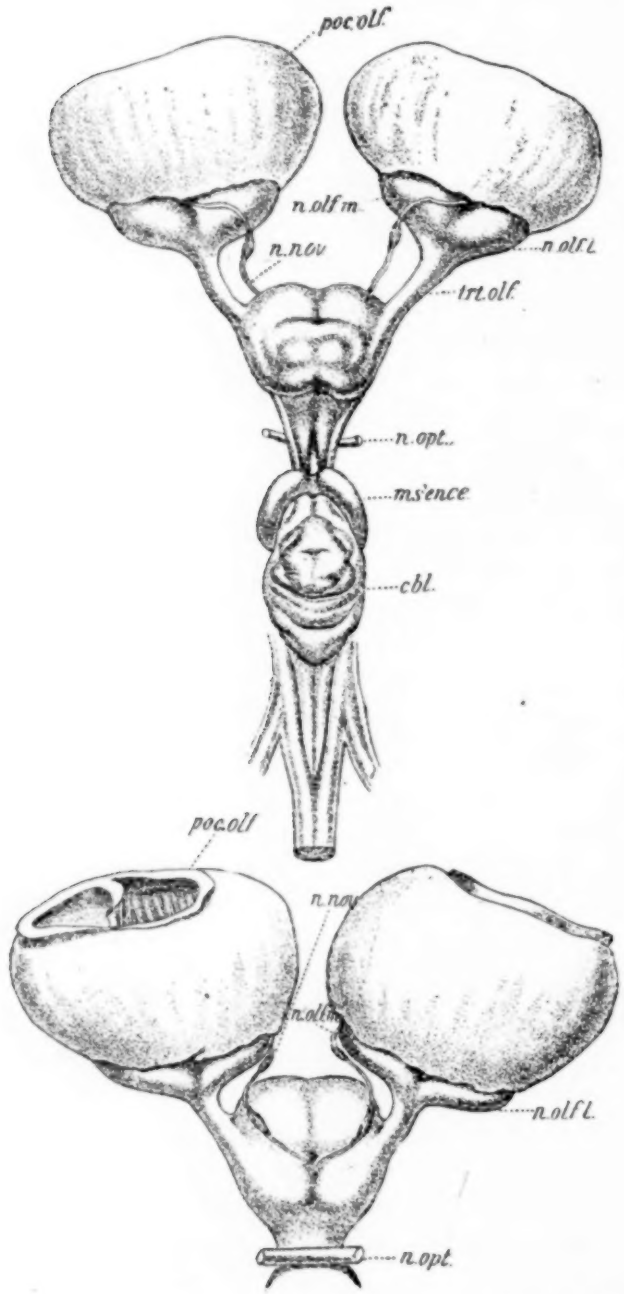

FIG. 5. Brain of adult *Mustelus canis*, from above, and portion of the same from below, both natural size.

their independence and do not anastomose with them.

The dorsal attachment of the nerve to the brain has been determined in eleven genera, and sets aside the idea that it is usually, or normally, connected with the ventral surface, as has been suggested on account of its ventral position in *Amia*, *Ceratodus* and *Protopterus*.

As an illustration of the other type, having a ventral attachment with the brain, we may take the brain of the common smooth hound (*Mustelus canis*) of the Atlantic coast, which is shown in Fig. 5. Here, the nerve emerges from (or enters) the brain substance on the ventral surface, about midway between the anterior border of the prosencephalon and the optic chiasma. It is interesting to note that, in embryonic development, it first arises upon the dorsal part of the primary fore-brain and is carried to its ventral position through the unequal growth of the brain-wall. The nerve penetrates the brain substance, and, after branching, terminates in the same region as in the brain of *Squalus acanthias*.

As shown in the figure, the nerve has two ganglia—a distal and a proximal one—as is the case with the ninth nerve. The peripheral distribution of the fibers is similar to that in *Squalus acanthias*.

A few comments in reference to this nerve may not be out of place. The only similar nerve known outside the group of selachians is in *Amia*, *Protopterus* and *Ceratodus*. In the two former genera no ganglion was observed by either Allis or Pinkus, but Sewertzoff, in 1902, noted a ganglion on this nerve in embryonic stages of *Ceratodus*. The ventral position of the nerve, close to the *recessus præopticus* in the three forms mentioned, led Sewertzoff to propose for it the name of '*Nervus præopticus*,' but its dorsal position in so many selachians would make that name inappropriate. Earlier (1899) I had suggested in a tentative way the name '*accessory olfactory*,' which is also objectional, as it prejudices the question of its function. Since this nerve arises on the morphological tip of the primary fore-brain, and during some stage of its existence is closely connected with the *lamina terminalis*, I think the designation '*Nervus terminalis*' will fit all cases and will be a suitable name for it.

Both its anatomy and embryology, as given in my paper in the *Anatomischer Anzeiger*, bring out its marked individuality and separateness from other cranial nerves. This would justify calling it a 'new nerve' and, therefore, giving it a new name.

In the selachians, its close association with the main olfactory and its distribution within the olfactory cup, might give ground for the suggestion that it is a radix mesialis of the olfactory nerve. This, however, appears to me not well founded, since the nerve has no connection, at any time of its growth, with olfactory glomeruli. Even if it be one of the olfactory bundles in an unusual position, its method of origin, and difference from all other olfactory radices would still justify the use of the designation 'new nerve.'

It is a relatively simple ganglionated nerve that has apparently undergone little modification. This, in itself, is a very notable circumstance, on account of its position on the brain in a region of extreme modification. Since it has remained in a relatively archaic condition, we may conclude that its function has not been greatly elaborated. It may have been largely supplanted by the development of the olfactory, or some of the branches of the trigeminus.

When all circumstances of its structure and development are taken into account, it seems to me not unlikely that we have here the remnant of a very ancient nerve, whose original function is unknown, which in the process of development has been reduced to secondary rank, through the prodigious development of adjacent nerves and brain territories.

It has been shown that this nerve precedes the olfactory in embryonic origin, but the assumption would not be justified on this account, that it is, therefore, older in phylogenetic history, though such may be the case.

Its development in so many adult selachians would indicate that it is still functional, though reduced to a subsidiary rank.

Its ganglion will throw it among sensory nerves.

But, while it has a sensory moiety, some considerations indicate that possibly it has also a motor moiety. It has two roots, and in the skate, both medullated and non-medullated fibers have been observed in it.

It will be extremely difficult to determine its physiological properties by experimentation. Its minuteness will render any manipulation or experimental study difficult without giving injury to the olfactory.

It is doubtful if any trace of it be preserved in higher vertebrates. Whatever its original function may have been, it was in some way superseded in the evolution of animal life, and having first lost its importance, it thereafter disappeared. I have looked with especial care for it in a number of amphibians and teleosts, and in the chick. Both embryonic and adult stages have been examined in *Necturus, Amblystoma,* the frog, the toad, the trout, the catfish and the chick, but in none of them has the nerve been found.

From any point of view, it is extremely interesting that we have preserved so fully in selachians and Dipnoi a ganglionated nerve in front of the optic, bearing in its anatomy testimony as to its ancient features, but of which all traces have disappeared in higher animals.

NOTE.—Since the above was sent to the printer the 'Nervus terminalis' has been observed in two rare selachians of ancient type —*Chlamydoselachus* and *Mitsukurina*. Professor Burt G. Wilder noted its occurrence in the former, photographed it, and, subsequently, sent me a portion of the brain embracing the nerve. In *Chlamydoselachus* it is similar in position and anatomical features to the nerve in *Hexanchus*. It is connected with the forebrain, within the median furrow, and upon the terma about midway between the dorsal and ventral surfaces. It runs directly to the olfactory cup. Near the base of the cup it has an enlargement which, upon microscopic examination, proved to contain ganglion-cells. As in *Hexanchus,* the main branch of the nerve joins the median instead of the lateral division of the olfactory fibers.

Professor Wilder also generously sent for my examination the anterior portion of the brain of *Mitsukurina*. In that rare and costly form the nerve is connected with the ventral surface of the brain by two roots. It has a very distinct ganglion lying on the olfactory crus near the base of the bulbus.

WILLIAM A. LOCY.

THE IMPORTANCE OF INVESTIGATIONS OF SEEDLING STAGES.[1]

THE selection of the title, 'The Importance of Investigations of Seedling Stages,' for presentation before the Section of Vegetable Morphology of the International Congress carries with it the suggestion that it is the intention of the writer to epitomize the recent attempts made to solve the problem of the phylogeny of Monocotyledons by reference to the anatomy of seedlings. The importance of these investigations is beyond question and the unexploited nature of the field has never been better expressed than by Miss Sargent, whose name occupies the most important place in these discussions, when she remarked that while theoretically the embryo should offer characteristics of unusual taxonomic importance, the only character so far of recognized value seems to be that employed in the separation of the two great divisions of the Angiosperms.

But this work has already been brought to the attention of botanists by foreign and American writers and I speak of it only incidentally in passing to the consideration of some other, though related, points, omitting, of necessity, many interesting and suggestive illustrations which would require far too much space for their adequate discussion.

The recent revival and defense of the conception of the cotyledon as homologous with the nursing foot of the lower forms rather than with foliar organs has suggested many problems which will require a broad comparative study of all embryonic stages for solution.

The functions performed by the cotyledons are various, the protection of younger embryonic regions, the deeper planting of the young seedling, and above all, elaboration, storage and absorption of food material, or in other cases the cotyledons are merely vestigial structures. If it be maintained that the cotyledon is homologous with a more primitive nursing foot and that the Dicotyledons are derived from the Monocotyledons by a bifurcation of an originally simple member, the whole series of adaptive modifications of the cotyledon must be studied and arranged in series in agreement with their origin.

This presents problems of no mean magnitude, physiological and morphological, the solution of which demands the accumulation of a vast series of comparative data. Not only do the differing degrees of physiological specialization and morphological modification of the cotyledon among Monocotyledons offer problems of interest and importance, but the evolution of epigean and hypogean cotyledons in the dicotyledons must be more satisfactorily traced. If the close resemblance of many cotyledons to foliar organs is merely similar structural adaptation to the same physiological function, the problem is not *solved,* but the point of view is simply changed, since the origin of such adaptations offers a group of knotty problems which will require painstaking research for their solution. If the cotyledons of many Onagraceæ are the homologues of haustorial organs, what is the nature and action of the 'correlation' which demands that the portion of the cotyledonary lamina interpolated after exposure to the light shall have a structure and venation in close agreement with that of the true leaves which follow rather than with the simple form and tissue of many other cotyledons which are photosynthetically active for a long time.

If, on the other hand, the old and generally accepted view is considered the correct one and cotyledons are regarded as foliar in nature, the series of forms is almost as puzzling and as much in need of broad and comparative investigation and arrangement.

The morphology of the cotyledon has been called into question through a consideration of the relationship of Monocotyledons and Dicotyledons. Apparent transitions from one great group to the other have been discovered. These apparent transition stages have been used to support two antagonistic views of the relationship of the two great groups. It is apparent that the special data so far secured are very meager and, if it exists, the connection between the two great groups must be

[1] Read before the International Congress of Arts and Science, St. Louis Exposition.

established by the discovery of a more complete series of transition stages. If, on the other hand, the forms to which so much significance has been attached are merely adaptations to peculiar life conditions, assumed by a plant at an exceedingly plastic stage of its development, the problem of the relationship of the two great groups seems to be farther than ever from a satisfactory solution.

The value of seedling characters for the tracing of phylogenetic development in families and lower systematic groups and an understanding of past changes both in the race and in its environmental conditions, has been emphasized by several writers. The most satisfactory results in this field are those obtained by Ganong and Cockyane, who have both worked principally with xerophytic forms which offer especially promising material for such researches, though here extreme caution must be exercised in deciding whether distinctive characters of the adult are not merely an expression of the direct influence of the environment upon a plastic organism, while the juvenile stages, owing to the different conditions of growth, are not subjected to these influences, and consequently all the potentialities of their primordia may be realized instead of intercepted and diverted or modified by powerful environmental influences. It scarcely need be suggested that here experimental morphology and ecology have before them material for a series of very interesting monographs.

A field in which results of especial interest may be expected is the comparative investigation of the later developmental stages within the same systematic group. For families Ganong has presented a masterly treatment of the Cactaceæ and Willis has accumulated some data for, and suggested the importance of, such work in the Podostemaceæ, while Miss Sargent's work on the Liliaceæ, when it appears, will doubtless represent the most extensive study of the kind ever undertaken. In other families there is a large store of details waiting for supplementary researches and correlation. The results so far obtained show beyond question the interest, ecological, morphological and phylogenetic, attached to the study of these groups. While I would not discourage the investigations of these larger groups, it must be admitted that in the present state of our knowledge there are many uncertainties connected with the generalizations concerning their phylogeny, and for the present especial importance should be attached to the investigation of the minor groups, particularly the genera. We have little right to assume the monophyletic origin of the most of the families, while with the genus this is more justifiable, though even here the greatest caution must be used. The embryonic stages, especially the later ones, should be of the greatest value in just this connection, for theoretically they ought to furnish us with an indication of form prevailing prior to the assumption of the more specialized adaptive characters.

But before we may draw conclusions as to the phylogeny of a group or conclude whether monophyletic or polyphyletic in its origin, from characters offered by the later embryonic stages of its members, we must first understand thoroughly the seedling and its reaction to all the factors influencing it. This is a field not for comparative work alone, but for physiological, ecological and experimental morphological investigations as well. Comparative studies are of the highest importance, but in this case they must be carried out upon material of systematically homogeneous nature. Until the appearance of Professor de Vries's epoch-making work no one has had available for study a series of forms unquestionably descended from the same ancestor. It is highly desirable that some one take up such types as the new elementary species of Professor de Vries for the purpose of ascertaining in how far there is a relation of ancestral characters and to what extent there is in the seedling a working back into the embryo of the characters of the adult. While the new species of *Œnothera* described by Professor de Vries are the simplest systematic units, there are some very suggestive points to be found in his descriptions. The relative stages of development at which the differential

characteristics of the new species make their appearance seem not without significance. In some there is an immediate and complete obliteration of the *Lamarckiana* characters, while in others, as in the 'atavism' of *O. nanella*, the new characters replace those of the old only at a later period of development. Such cases as that of *Trifolium*, in which there was a working back into the embryo of the divided condition of the leaf as the number of leaflets characteristic of the mature plants increased offer suggestion for an important phase of statistical investigation. Investigations of the seedlings of some of the teratological 'varieties' may be expected to yield results of great interest, especially when taken up from the experimental and historical point of view.

The chief object of the study of seedling stages, phylogeny, is dependent for its realization upon the validity of the recapitulation theory. In many cases this seems to hold, but, as pointed out above, a broad, comparative investigation of minor groups is imperative. Results of importance are assured. Developmental stages in the same group will generally show either a close similarity or present a series of perplexing differences. The conclusion in the one case will be that community of descent or identical environmental conditions are responsible. In the other case —and of this a considerable number of striking illustrations might be cited—polyphyletic origin of groups hitherto supposed to be monophyletic must be assumed, or the differences must be accounted for on the ground of adaptation or mutation and the importance of ontogeny as a key to phylogeny greatly restricted. With reference to seedling stages the statement that ontogeny recapitulates phylogeny must be made with great reserve. Doubtless it has here an evolutionary significance, but its application is a matter of serious import. It seems to me that in vast numbers of cases, the sweeping back of later developed characters in the nature of adaptations to environment or otherwise has obliterated ancestral features, especially the superficial ones, to such an extent that an attempt to reconstruct the phylogenetic tree is quite out of the question.

In the examination of seedling stages, experimental morphology may find, as we have already suggested above, a fertile field for research in the determination of the degree of plasticity of juvenile and adult types. Some structures seem to be merely the result of the direct environmental influence, but others can not be modified by the changing of conditions. Some characters seem to be well fixed, while others are apparently merely the product of immediate influences of the environment. While phylogeny is the chief end, experimental morphology may find in seedling stages material of value for use in the formulation and solution of some of its fundamental problems.

J. Arthur Harris.
Missouri Botanical Garden and
Washington University, St. Louis.

Current Notes on Meteorology.

Cyclonic and Anticyclonic Temperatures.

A very useful summary of 'Various Researches on the Temperature in Cyclones and Anticyclones in Temperate Latitudes' has been prepared by H. Helm Clayton, of Blue Hill Observatory, and is published in *Beiträge zur Physik der freien Atmosphäre*, Vol. I., No. 3, 1905. It is probably known to men of science generally that one of the most interesting of present-day problems in meteorology concerns the origin of the cyclones and anticyclones which are such characteristic phenomena of the prevailing westerly wind belts, and constantly impress themselves upon us by reason of their control of our weather changes. Mr. Clayton presents an outline of the work of Hann, Dechevrens, Berson, Teisserenc de Bort, Rotch and others, including his own important results; points out the contradiction which exists between the conclusions of those who believe that cyclones are colder than anticyclones and those who find them to be warmer, and gives it as his opinion that both sets of investigators may be partly right. The author calls attention to the fact that those who have found the cyclone colder have considered the temperature in relation

to pressure without regard to time, while those who find the cyclone the warmer have, with one exception, considered the temperature with relation to the time of maxima and minima of pressure. A treatment of the data used by Teisserenc de Bort according to the method adopted by Clayton, leads the latter to results exactly the opposite of those obtained by the former.

In order to explain the results found at Blue Hill, Clayton has adopted the hypothesis that there are two causes for areas of low pressure: (1) an area of cold which contracts the air and tends to cause cyclonic circulations in the upper air, and (2) an area of warmth which expands the air and tends to cause cyclonic circulations in the lower air. These two cyclones are not necessarily connected. Both affect surface pressures, and both probably usually exist simultaneously within a few hundred kilometers of each other, and may form part of one system. The warm-air cyclone of the surface has hitherto received the most attention. In this somewhat complex relation of upper and lower cyclones, as hypothecated by Clayton, we may find a satisfactory adjustment of conflicting views.

METEOROLOGY AT COLORADO COLLEGE, COLORADO SPRINGS.

METEOROLOGY is developing under favorable auspices at Colorado College, under the direction of Professor F. H. Loud. The observatory building, erected in 1894, was the gift of Henry R. Wolcott, Esq., of Denver. There is a full equipment of meteorological instruments, some of which are exposed on the flat roof of the observatory, while others are placed on the roof of a neighboring building, east of the observatory and on higher ground. Tri-daily eye observations are made, and from the self-recording instruments the conditions at the end of each hour during the twenty-four are determined. Monthly and annual summaries for 1904 are contained in the *Semi-Annual Bulletin of the Colorado College Observatory* (*Colo. Coll. Studies;* Gen. Ser., No. 16; Science Ser., Nos. 39–41; Vol. XI., pp. 119–190; April, 1905). In addition, Professor Loud discusses the topography of the district, the diurnal changes of atmospheric conditions (illustrated by curves) and the cold wind of October 24, which came at the time of the usual morning increase of temperature and gave a daily maximum at 4 A.M. This wind, which was observed by two parties at high altitudes, began with a shallow flow of cold air from the north, in front of an approaching anticyclone. The cold stratum seems to have run beneath the quiet air of the region, lifting it and giving rise to a thin stratum of cloud which resulted from condensation by reason of ascent. Sometimes these conditions give rise to a slight fall of snow. A paper on 'The Evolution of the Snow Crystal,' by John C. Shedd, embodies some results of studies made during the winter of 1901–02 at Colorado Springs. The author believes that the primitive crystal is, for the tabular form, of the 'fern stellar' type, *i. e.,* open in structure and with many branches, while for the columnar form it is the hollow column; that the solid tabular, solid columnar or granular forms are the final forms to which all others tend, and that there are two general processes of transformation from primitive to final forms. One process is that of accretion, and the other is that of transformation, in which the losses and gains result in a change in form, but not necessarily in amount of material.

NEOLITHIC DEW-PONDS.

A RECENT study of 'Neolithic Dew-ponds and Cattle-ways,' by A. J. and G. Hubbard (London, Longmans, Green and Co., 1905), brings out some interesting evidence of the construction of dew-ponds by the early inhabitants of Great Britain. The process of construction was as follows: An exposed position where springs were absent was selected, and the hollowed surface was covered over with straw or some other non-conducting material. Over this was spread a thick layer of clay, strewn with stones. Condensation during the night from the lower air on the cold surface of the clay provided the water-supply for the pond. Springs and drainage from higher ground were avoided, because running water would cut down into the clay surface

and wet the straw. Some of these ponds, of very early date, perhaps Neolithic, are still in working order.

PILOT CHARTS OF NORTH ATLANTIC AND NORTH PACIFIC OCEANS.

THERE is much of interest to teachers of physiography and of meteorology on the monthly pilot charts of the Atlantic and Pacific Oceans issued by our Hydrographic Office. So far from containing only information for the use of mariners, there is a large amount of material which may easily be employed in school and college teaching. For example, the conditions of prevailing winds and calms; the limits of the trades; the interaction of general and local winds near the coasts of continents and islands; the distribution of fogs and many other subjects of direct meteorological interest are discussed, as well as charted, on these publications.

SUICIDE AND THE WEATHER.

M. DENIS has recently published a study entitled 'Le Suicide et la Corrélation des Phenomènes moraux en Belgique' (*Mem. Acad. roy. Belg.*), in which the relation of suicide and the weather is considered. At Brussels the number of suicides increases up to July and August, and the minimum is usually in December (*Ciel et Terre*, Vol. 26, 1905, No. 6). R. DEC. WARD.

RECENT VERTEBRATE PALEONTOLOGY.

PARTIES are now in the field from the Carnegie Museum, the Field Columbian Museum and the American Museum of Natural History. From the last institution three parties have been sent out, one to continue the work of excavation in the 'Bone Cabin' Quarry in search especially for additional skulls of dinosaurs; the second to the Bridger Eocene basin, in order to verify the stratigraphic exploration which has been done there and to complete our knowledge of certain little known forms; the third to the Laramie or Upper Cretaceous of northern Montana in search of dinosaurs. In the absence of Professor Bashford Dean in Japan, his assistant, Mr. Hussakof, is exploring several of the type localities of Devonian fishes.

Much activity is also being displayed in the arrangement of the collections in the various museums. Mr. J. W. Gidley, who resigned his position in the American Museum for an appointment as preparator in the National Museum, is completely overhauling and cataloguing the rich National Museum collection. In the Carnegie Museum the specimens are temporarily withdrawn from exhibition pending the completion of the new building. In the American Museum of Natural History the skeleton of the little Bridger armadillo *Metacheiromys* has just been placed on exhibition, while the skeletons of the Pampean horse *Hippidium*, of the Jurassic carnivorous dinosaur *Allosaurus* and of the Pleistocene mammoth *Elephas columbi*, are being prepared for mounting. Mr. Richardson, who prepared such an admirable model of *Stegosaurus* for the National Museum exhibit at the St. Louis exposition, is now preparing for a life-size reproduction of *Allosaurus* after a model by Knight from the skeleton in the American Museum of Natural History.

The principal researches in this museum at the present time are the following: Dr. O. P. Hay is monographing the Testudinata on a grant from the Carnegie Institution. Dr. E. C. Case is writing a memoir upon the Permian Pelycosauria, especially the great fin-backed lizards *Naosaurus* and *Dimetrodon*, fine specimens of which are preserved in the Cope collection in this museum; the drawings for this memoir are being made from a grant from the Carnegie Institution. Dr. W. D. Matthew has been revising the Bridger fauna, especially the Carnivora and Insectivora. Mr. Barnum Brown has completed a description of an important Pleistocene cave fauna of Arkansas. Volume II. of 'The Fossil Vertebrates in the American Museum of Natural History' has recently been issued, including forty-four collected bulletins, from 1898 to 1903, by Osborn, Wortman, Matthew, Hay, Granger, Gidley, Loomis, Brown, Lull, Gregory.

The status of the U. S. Geological Survey monographs at present is as follows: The monograph on the Ceratopsia by the late Mr. J. B. Hatcher will be published first. The

author at the time his fatal illness overtook him was in the midst of the final pages of the systematic revision of genera and species; he left his manuscript, so far as prepared, in perfect condition. Professor R. S. Lull, of the Massachusetts Agricultural College, has completed the monograph, carefully conforming, so far as possible, to the plans of the author. It has been found necessary, however, to add considerable original matter. The Titanothere monograph is progressing rapidly in the hands of Professor Osborn; recent discoveries in Wyoming have added greatly both to the material and to the work involved in completing this volume. The Sauropoda monograph by the same author is also under way, but will not be completed for at least two years. It has been practically decided to confine the Stegosauria monograph, in the hands of Mr. F. A. Lucas, to the genus *Stegosaurus* and thus avoid the delay incidental to the study of the European members of this order. H. F. O.

SCIENTIFIC NOTES AND NEWS.

THE fiftieth year of public service of the eminent chemist Dr. D. J. Mendeléef will be celebrated at St. Petersburg on August 30.

DR. SAMUEL G. DIXON, president of the Academy of Natural Science of Philadelphia, has been appointed commissioner of health for the state of Pennsylvania.

PROFESSOR W. W. MILLS has been appointed state geologist of Michigan.

DR. ROBERT KOCH, who is said to be making important discoveries in the interior of Africa, expects to return to Germany in the spring of next year.

PROFESSOR C. H. HITCHCOCK, of Dartmouth College, is this summer studying the volcanoes of the Hawaiian Islands.

PROFESSOR G. F. WRIGHT, of Oberlin College, is making a trip to southern Russia and the Red Sea to continue his geological and anthropological studies in that region.

DR. J. F. NEWSON, associate professor of mining and metallurgy at Stanford University, has leave of absence for next year.

PROFESSOR MORIZ BENEDIKT, of the University of Vienna, known for his work on diseases of the nervous system, has celebrated his seventieth birthday. A dinner was given in his honor by the Neurologic Society of Vienna and congratulations were presented from various societies of which he is a member.

THE gold medal of the British Medical Association has been presented to Sir Constantine Holman and to Mr. Andrew Clark.

THE French Académie de Médecine has awarded a silver medal to Dr. Alan Green, bacteriologist in charge of the vaccine lymph department, Lister Institute of Preventive Medicine, for his work on vaccine.

DR. GUSTAV KRAATZ, president of the German Entomological Society, has been given the title of professor.

DR. RICHARD ASSMANN, titular professor of meteorology at Berlin, has been appointed director of the aeronautical observatory at Lindenberg.

WE learn from the London *Times* that Mr. Edgar Schuster, the Francis Galton research fellow in national eugenics at London University, has presented a report containing a preliminary account of inquiries which have been made into the inheritance of disease, and especially of feeble-mindedness, deaf-mutism and phthisis. Arrangements have been concluded with Mr. John Murray for the publication of a work on noteworthy families in modern science, written by Galton in conjunction with Mr. Schuster. This is to appear as Volume I. of the publications of the Eugenics Record Office, and will contain accounts of the families of some fifty fellows of the Royal Society.

A STATUE of Benjamin Franklin is to be erected at Paris at the end of the street that bears his name. Plans have been made for the celebration of the two hundredth anniversary of Franklin's birth, which occurred on January 17, 1706, in Boston and New York as well as in Philadelphia.

Nature states that a portrait medallion, in marble, of Sir William Geddes, the late principal of the University of Aberdeen, has been

completed, and will be placed in the Geddes transept of the library at King's College. Its unveiling will probably take place at the beginning of the winter session. A meeting in furtherance of the proposed memorial to the late Professor James Nicol was held recently in Marischal College, when a number of letters from geologists and old pupils of Professor Nicol were read, the general tenor of which favored the placing of a portrait tablet in bronze in the geological museum. There will be, it is hoped, a formal inauguration of the memorial during the centenary celebrations of next year.

Mr. Guy M. Bradley has been killed while protecting the birds of the Florida coast in the service of the National Association of Audubon Societies.

Dr. J. L. Chaufleury van Ysselstein, formerly professor of medicine at Amsterdam, has died at the age of eighty-six years.

Dr. Eduard Tangl, professor of botany at the University of Czernowitz, has died at the age of fifty-seven years.

Dr. Paul Schultz, docent in physiology in Berlin, died on July 18, at the age of forty-one years.

We learn from *The American Geologist* that the late legislature of Illinois established a state geological survey, putting it under the immediate direction of the trustees of the state university at Urbana, but with an advisory board consisting of the governor, the president of the university and one other to be appointed by the governor. The annual appropriation is twenty-five thousand dollars. In addition to the above, the university is to have a school of ceramics supported by an appropriation of five thousand dollars per year. This, however, will have no connection with the survey except such as common interest dictates.

The international committee having in charge the International Catalogue of Scientific Literature met in London during the last week in July.

The British Medical Association opened its annual meeting at Leicester, on July 25, under the presidency of Dr. George Cooper Franklin. The association will meet next summer in Toronto.

The fourth meeting of the German and Vienna Anthropological Society will be held at Salzburg on the 28th to the 30th of the present month.

An announcement has been issued in regard to the International Congress on Tuberculosis, to be held at Paris from October 2 to 7. There will be four sections, medical pathology, surgical pathology, preservation and assistance of infants and the same for adults.

We learn from *The British Medical Journal* that the International Surgical Congress will meet at Brussels beginning September 18, under the presidency of Theodor Kocher, M.D., professor of surgery in the University of Berne. The morning of each day will be arranged for visits to hospitals and clinics, and for the presentation and examination of patients, and for other matters of interest connected with the congress as well as the city of Brussels. The afternoons will, as far as possible, be reserved for the consideration of the subjects selected for discussion. These are as follows: (1) The value of the examination of the blood in surgery; (2) the treatment of prostatic hypertrophy; (3) surgical intervention in non-cancerous diseases of the stomach; (4) treatment of articular tuberculosis; (5) the treatment of peritonitis; (6) the diagnosis of surgical diseases of the kidney. Other communications of a practical nature (of which due notice should be given, as well as the time they will occupy) including the presentation of patients, specimens, and surgical instruments and appliances may be made. The official languages of the congress are English, French, German and Italian.

The General Council of Chambers of Commerce of the Commonwealth of Australia, at a meeting held in Sydney, in June, the following resolution passed: "That this General Council of the Chambers of Commerce of the Commonwealth of Australia views with satisfaction the increasing public interest in the metric system of weights and measures, and

expresses the hope that it may very shortly be adopted for England and the empire generally, and recommends that such legislation may now be framed in the commonwealth as will enable us to at once follow the home country in this change."

IT is stated in *Nature* that the council of the Royal Meteorological Society, being desirous of advancing the general knowledge of meteorology and of promoting an intelligent public interest in the science, has appointed a lecturer who is prepared to deliver lectures to scientific societies, institutions and schools on payment of a moderate fee and the cost of traveling expenses, the subjects being—how to observe the weather; weather forecasting; climate; rainfall; thunderstorms; meteorology in relation to agriculture, health, etc. The society is also prepared to lend and fit up a complete climatological station for exhibition, showing the necessary intruments in position and ready for use, and to lend in return for a nominal amount sets of lantern slides illustrating meteorological phenomena.

ENGLISH journals state that the government of India has ordered the introduction of a standard time, with effect from July 1, on the railways (other than small local lines, where the change might be inconvenient) and in all telegraph offices in the country, and also in Burma. Hitherto Madras time has been adopted by most of the Indian railways. The standard now to be introduced is nine minutes in advance of the 'railway time,' as it is called in all parts of India, and is thus 5½ hours in advance of Greenwich, being the local time of longitude 82° 30′. The standard for Burma is to be exactly an hour earlier, viz., 6½ hours in advance of Greenwich and five minutes earlier than Rangoon local time. In inland places it has been found convenient generally to follow railway time; but the great seaports of Calcutta, Bombay and Karachi have followed the local time of their respective longitudes. The government of India does not prescribe the new standard for these and other places following local time, but if a general desire to adopt the new standard is evinced, the government will be prepared to support the change and to cooperate in bringing it about. In all probability, therefore, there will ere long be a uniform time throughout India exactly 5½ hours in advance of Greenwich, while that of Burma will be 6½ hours in advance.

Nature says: "The proposal made by the Emperor of Germany for the temporary interchange of professors with America for a course of lectures is leading to a number of important results. Harvard University has invited Professor Ostwald, of Leipzig, to give a half year's course and Columbia University has secured lectures from Professor V. F. Bjerknes, of Stockholm, on 'Fields of Force,' and from Professor H. A. Lorentz, of Leyden, on 'Extensions of Maxwell's Electromagnetic Theory.' Is Great Britain with its usual insularity going to keep aloof from the new movement? It is hardly likely that any proposal from our country would fail to obtain hearty support either in Germany or in America."

UNIVERSITY AND EDUCATIONAL NEWS.

A COMMITTEE of the alumni of the Massachusetts Institute of Technology, with Mr. F. L. Locke, '86, as chairman, has addressed a circular to the alumni asking their opinion of the advisability of opposing in the courts the recent vote of the corporation of the institute in favor of an alliance with Harvard University. It states that a league has been formed "to oppose the contemplated alliance with Harvard University or any similar alliance; to defend the educational freedom of the Massachusetts Institute of Technology, and to promote the influence of the faculty and past students in its government." In regard to the action of the corporation, it says: "Such extraordinary exercise of corporate power in marked disregard of the moral obligation to respect the opinions and desires of those directly interested in the welfare of the institute raises a question more important even than the abandonment of its independent educational policy."

MRS. E. A. JEFFERS, of Richmond, Ind., has bequeathed $60,000 to Ohio Wesleyan University and $35,000 to De Pauw University.

The American Geologist states that Mr. G. K. Gilbert has given to the department of geology of Denison University upwards of 1,000 volumes of literature, consisting of U. S. Geological Survey reports, state reports, reprints, proceedings and other valuable books. It will be remembered that the library of the university was destroyed by fire some time since.

The Vienna correspondent of the London *Times* writes that the prime minister has laid before the House of Parliament a bill empowering the government to devote 25,000,000 crowns for the purposes of higher education, chiefly for medical teaching. The sum will cover the cost of building a new institute for physico-medical investigations, a new institute for hygiene in Vienna, and a new central home for several medical institutions of minor importance. In Prague both the German and the Czech universities are to be reconstructed; in Lemberg a new clinic for medicine and for surgery is to be provided; and in Cracow new clinics are to be erected and a medical library is to be founded.

The amount allotted by Parliament to each of the University Colleges for the year 1905–6 will be as follows:

Manchester	£12,000
University College, London	10,000
Liverpool	10,000
Birmingham	9,000
Leeds	8,000
King's College, London	7,800
Newcastle-on-Tyne	6,000
Nottingham	5,800
Sheffield	4,600
Bedford College, London	4,000
Bristol	4,000
Reading	3,400
Southampton	3,400
Dundee	1,000
	£89,000

A chair of protozoology has been established in the University of London, the secretary of state for the colonies having arranged for an appropriation for this purpose of £700 a year for five years. The academic council has further appropriated a sum of £200 a year for assistants and laboratory expenses in connection with the chair.

Professor Maynard M. Metcalf, of the Woman's College of Baltimore, has been appointed professor of zoology at Oberlin College.

Dr. Austin Flint Rogers, of Columbia University, has been made assistant professor in the department of geology and mining at Stanford University.

Dr. Oliver M. W. Sprague, assistant professor of economics at Harvard University, has accepted a chair at the University of Tokio.

At the University of Colorado, Mr. J. H. Wallace, B.S. (Illinois), has been appointed instructor in graphics, and Mr. Saul Epsteen, A.B. (California), Ph.D. (Zurich), instructor in mathematics.

Dr. Wilfred H. Manwaring, S.B. (Michigan, '95), M.D. (Hopkins, '04), at present fellow of the Rockefeller Institute for Medical Research and assistant in pathology in the University of Chicago, has been appointed head of the new department of pathology and bacteriology in Indiana University, with the rank of associate professor.

Mr. Leroy D. Swingle, A.B. (Lafayette), science teacher in Seattle (Wash.) Seminary, has been appointed fellow in zoology at the University of Nebraska.

Professor A. R. Simpson has retired from the chair of midwifery at the University of Edinburgh after a service of thirty-five years. Professor Simpson was the nephew and successor in the chair of Sir James Young Simpson, the discoverer of chloroform as an anesthetic.

Dr. Otto Dimroth, professor of chemistry at Tübingen, has been called to Munich.

Dr. Alois Riehl, professor of philosophy at Halle, has accepted a call to Berlin.

Dr. Karl Isidor Cori, director of the Zoological Station at Trieste, has been promoted to a professorship of zoology at the German university at Prague.